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The genus *Wrightoporia* in Korea

Yeongseon Jang[1], Sung Wook Lee[1], Young Woon Lim[2], Jin Sung Lee[3], Tsutomu Hattori[4] & Jae-Jin Kim[1]*

[1]*Division of Environmental Science & Ecological Engineering, College of Life Sciences & Biotechnology, Korea University, 5-1 Anam-dong, Seongbuk-gu, Seoul, 136-701, Korea*
[2]*School of Biological Sciences, Seoul National University, Seoul, 151-747, Korea*
[3]*National Institute of Biological Resources, Environmental Research Complex, Incheon, 404-708, Korea*
[4]*Kansai Research Center, Forestry and Forest Products Research Institute, Biodiversity Research Group, Nagai-Kyutaro 68, Momoyama-cho, Fushimi-ku, Kyoto, 612-0855 Japan*
*Correspondence to: *jae-jinkim@korea.ac.kr*

Abstract —The genus *Wrightoporia (Hericiales, Basidiomycota)* and two species, *W. japonica* and an undetermined *Wrightoporia* sp. are reported as new to Korea. *Wrightoporia luteola* is treated as a synonym of *W. japonica*. Illustrated descriptions and a key to Korean *Wrightoporia* species are provided.

Key words — ITS, nuc-LSU, phylogeny, polypore, taxonomy

Introduction

Wrightoporia Pouzar is a genus of wood-rotting fungi. The current generic concept is broad and the genus includes species with: (1) resupinate to pileate basidiocarps; (2) poroid hymenophore; (3) smooth to ornamented and amyloid basidiospores; and (4) diverse hyphal characters such as monomitic or di–trimitic hyphal system, generative hyphae with or without clamp connections, and skeletal hyphae with or without a dextrinoid reaction. Some species also have gloeoplerous hyphae (Hattori 2008). A total of 38 *Wrightoporia* species have been described so far according to Index Fungorum databases (http://www.indexfungorum.org/Names/Names.asp), and they have been found in both tropical to temperate areas. Of the 18 species reported from Asia, some have been described from Asia (Hattori 2008), but none have been recorded in Korea.

During studies of indigenous fungi, especially polypores, we found three *Wrightoporia* specimens. Our examinations and sequence analysis established that they represented *W. japonica* and an undetermined *Wrightoporia* sp. We also determined that *W. luteola* is a taxonomic synonym of *W. japonica*.

Materials & methods

Collection and morphological examination

Basidiocarps were collected from Mt. Guryong and Mt. Dobong in Seoul, Korea, and Mt. Songni in Chungcheongbuk-do, Korea, in 2011. They were dried completely overnight using an air drier at 40°C. Slide preparations were made from dried specimens mounted in 5% (w/v) KOH, 1% (w/v) phloxine and Melzer's reagent (Largent et al. 1977) using an Olympus BX51 light microscope (Olympus, Tokyo, Japan). The abbreviations used in the text are as follows: IKI– = inamyloid, L = mean spore length, W = mean spore width. Munsell soil color charts (Munsell Color 2000) was used as the color standard. The voucher specimens were deposited at the National Institute of Biological Resources, Incheon, South Korea (KB) with the acronym KUC (Korea University Culture Collections, Korea University, Seoul, South Korea).

Phylogenetic analysis

The genomic DNAs were extracted according to Jang et al. (2012a). PCR amplification reactions were performed with the primers LR0R/LR3 or LR0R/LR5 for nuclear large subunit ribosomal DNA (nuc-LSU) region (Vilgalys & Hester 1990) and ITS1F/ITS4 for internal transcribed spacer (ITS) region (Gardes & Bruns 1993, White et al. 1990) according to Jang et al. (2012a). The DNA sequencing was performed at the DNA sequencing center (Macrogen, Korea). The obtained sequences were deposited in GenBank. They were aligned with the reference sequences selected by BLASTn search of GenBank using MAFFT 6.885, L-INS-i alignment method (Katoh & Toh 2008). Each dataset was manually edited using MacClade 4.08 (Maddison & Maddison 2005). The aligned nuc-LSU dataset of 20 taxa comprised 911 characters, and the aligned ITS dataset of 19 taxa comprised 656 characters. Gaps were treated as missing. GTR + I + G model was applied for both of the datasets via MrModeltest 2.3 under the AIC (Nylander 2004). Bayesian analysis of each dataset was performed with MrBayes 3.2.1 (Ronquist et al. 2012). A 50% majority-rule consensus tree for each dataset was constructed according to Jang et al. (2012b). Two runs with 1,000,000 generations were performed and every 100th generation was sampled. Among them, the last 75% sampled trees were used. The tree was viewed using FigTree 1.3.1 (http://tree.bio.ed.ac.uk/software/figtree/).

Taxonomy

Wrightoporia japonica Núñez & Ryvarden, Fungal Diversity 3: 119. 1999. Fig. 1

= *Wrightoporia luteola* B.K. Cui & Y.C. Dai, Nova Hedwigia 83: 160. 2006.

Basidiocarps annual, resupinate to effused-reflexed, adnate, ca. 13.5 cm or more in longest dimension, ca. 5.5 cm in widest dimension in Korean specimens. Sterile margin narrow, obtuse, felty-corky, very pale brown (10YR8/4), less than 1 mm wide. Pileus elongated, up to 6 mm wide in Korean specimens; pileus

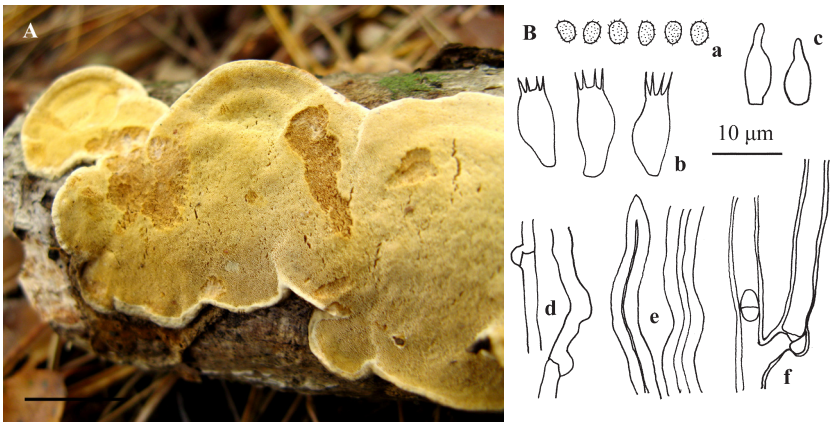

Fig. 1. *Wrightoporia japonica*. A. Basidiocarp (KUC20111019A-29). Scale bar = 1 cm. B. Microscopic features (a–e, KUC20110908-13; f, KUC20111019A-29). a, basidiospores; b, basidia; c, cystidioles; d, generative hyphae from trama; e, skeletal hyphae from trama; f, generative hyphae from context.

surface glabrous, dull, brownish yellow (10YR6/6), often darker near the base; pileus margin thin, entire, somewhat darker than the sterile margin, less than 1 mm wide. Pores round to angular, 7–8/mm in Korean specimens; dissepiments thin and entire; pore surface very pale brown (10YR8/4) to brownish yellow (10YR6/8) in dried condition, slightly shiny when turned in incident light. Subiculum felty-corky, concolorous to the pore surface, up to 1 mm thick. Tubes felty-corky, pale yellow, up to 1 mm deep.

Hyphal system dimitic; generative hyphae with clamp connections and skeletal hyphae.

Subiculum generative hyphae with clamp connections, hyaline, thin to slightly thick-walled, 1.5–4.5 μm in diameter; skeletal hyphae hyaline to yellowish, thick-walled, occasionally branched, straight to sinuous, 3–6 μm in diameter, most with a narrow lumen, some hyphae covered with crystals, interwoven, IKI–.

Tubes generative hyphae with clamp connections, hyaline, thin to slightly thick-walled, 1.5–3 μm in diameter; skeletal hyphae abundant, hyaline to yellowish, thick-walled, unbranched, straight to sinuous, 2.5–5 μm in diameter, mostly with a narrow lumen, some hyphae covered with crystals, interwoven, partly dextrinoid especially in the dissepiments; cystidia none, fusoid cystidioles present in one specimen (KUC20111019A-29); basidia oblong ellipsoid to clavate, 4 sterigmate, 9–12.5 × 4–5.5 μm.

Basidiospores broadly ellipsoid to subglobose, hyaline, thin-walled, with finely asperulate ornamentations, amyloid, 2.6–3.5 × 1.6–2.6 μm, L = 3.25 μm, W = 2.28 μm.

Type of rot— white rot.

Specimens examined: **KOREA**, **Seoul**, Mt. Guryong, 37°28′43″N 127°04′04″E, on fallen wood branch, 08 September 2011, Yeongseon Jang (KB, KUC20110908-13; GenBank KC166692). **Chungcheongbuk-do**, Mt. Songni, 36°38′07″N 127°25′49″E, on fallen wood branch, 19 October 2011, Yeongseon Jang, (KB, KUC20111019A-29; GenBank KC166693). **JAPAN**, **Okinawa Pref.**, Iriomote Isl., riverside of Shiira River, 19 June 1994, M. Núñez (isotype of *W. japonica*, TFM F-20724). **CHINA. Anhui Prov.**, Huangshan County, Yellow Mts., 13 October 2004, B.K. Cui (isotype of *W. luteola*, TFM, ex Dai 6199); **Fujian Prov.**, Wuyishan, the Virgin Forest Park, Longfenggu Scenicspot, 19 October 2005, Y.C. Dai (TFM, ex Dai 7221).

Distribution — China, Japan and Korea.

Remarks — *Wrightoporia japonica* was first described by Núñez & Ryvarden (1999), and Hattori (2008) gave a more detailed description based on ten specimens including the isotype. An examination of the *W. luteola* type showed it to be a resupinate form of *W. japonica,* which is morphologically similar to *W. gillesii* A. David & Rajchenb. (Hattori 2008). Further study is desirable to reveal whether they represent two distinct species.

***Wrightoporia* sp.** Fig. 2

Basidiocarps annual, resupinate, adnate, and confluent. Pores angular, 5–6/mm, dissepiments thin and entire, partly eroded; pore surface very pale brown (10YR8/4). Marginal sterile zone indistinct to membranous, very pale brown (10YR8/2), up to 2 mm wide. Subiculum very thin, less than 0.5 mm. Tubes concolorous to the pore surface, up to 1 mm deep.

Hyphal system dimitic; generative hyphae with clamp connections and skeletal hyphae.

Subiculum generative hyphae with clamp connections, hyaline, thin to slightly thick-walled, 1.5–5 µm in diameter; skeletal hyphae hyaline to yellowish, thick-walled, occasionally branched, straight to sinuous, 2.5–6 µm in diameter, mostly with a narrow lumen, interwoven, IKI–.

Tubes generative hyphae with clamp connections, hyaline, thin to slightly thick-walled, 1.5–3.5 µm in diameter; skeletal hyphae abundant, hyaline to yellowish, thick-walled, unbranched, straight to sinuous, 3–6 µm in diameter, mostly with a narrow lumen, interwoven, partly dextrinoid especially in the dissepiments; cystidia none, fusoid cystidioles scattered; basidia clavate, 4 sterigmate, 10.5–12.5 × 3.5–5 µm.

Basidiospores broadly ellipsoid to subglobose, hyaline, thick-walled, finely asperulate, amyloid, 3.2–4 × 2.4–3.2 µm, L = 3.62 µm, W = 2.85 µm.

Type of rot — white rot.

Specimen examined: **KOREA**, **Seoul**, Mt. Dobong, on fallen wood branch, 22 September 2011, Yeongseon Jang (KB, KUC20110922-37; GenBank KC166694).

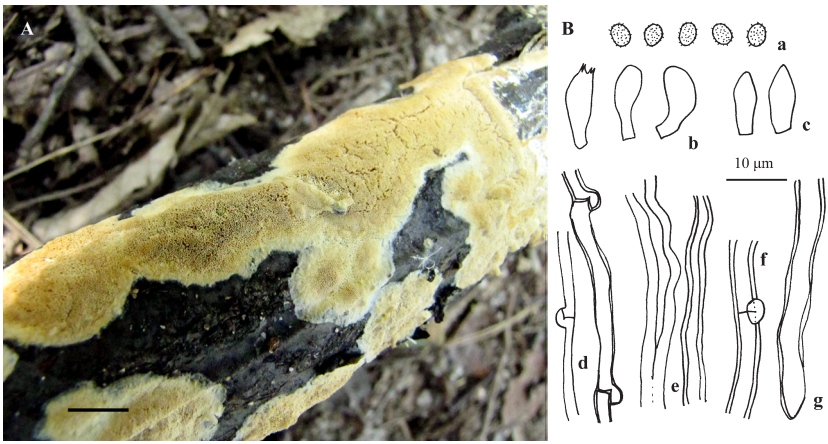

Fig. 2. *Wrightoporia* sp. (KUC20110922-37). A. Basidiocarp. Scale bar = 1 cm. B. Microscopic features. a, basidiospores; b, basidia; c, cystidioles; d, generative hyphae from trama; e, skeletal hyphae from trama; f, generative hyphae from context; g, skeletal hyphae from context.

Remarks — For the time being, we refer this to *Wrightoporia* sp. because the species outline is ambiguous with only a single specimen available. The specimen is similar to *W. japonica* but is distinguished by the purely resupinate basidiocarps with a very thin subiculum, partly eroded dissepiments, slightly larger spores (3.2–4 µm long), and parallel hyphae in the trama.

Phylogeny

Bayesian analyses of nuc-LSU and ITS regions were performed for the better understanding of phylogenetic relationships with other *Wrightoporia* and allied species available in GenBank. As shown in Larsson & Larsson (2003), *Wrightoporia* species are polyphyletic in both trees (Fig. 3; LSU tree not shown). Our specimens of *W. japonica* (KUC20010908-13 and KUC20111019A-29) have the same nuc-LSU and ITS sequences and form monophyletic clades in both trees. The ITS analysis (Fig. 3) clusters *W. luteola* (Dai 7221 from China) with *W. japonica* with high posterior probability value (1.0 p.p.), separated in the aligned ITS dataset by only two base-pair differences and one gap. This result supports our morphological observation that *W. luteola* is identical with *W. japonica*. *Wrightoporia* sp. KUC20110922-37 was monophyletic with *W. lenta* (Overh. & J. Lowe) Pouzar KN150311 from Jamaica in both trees, but this was only weakly supported (nuc-LSU, 0.54 p.p.; ITS, 0.65 p.p.). *Wrightoporia* sp. KUC20110922-37 is morphologically similar to *W. japonica*, and the *Wrightoporia* sp.–*W. lenta* clade clustered with *W. japonica* in the nuc-LSU tree (not shown). The ITS tree does not resolve the relationships among

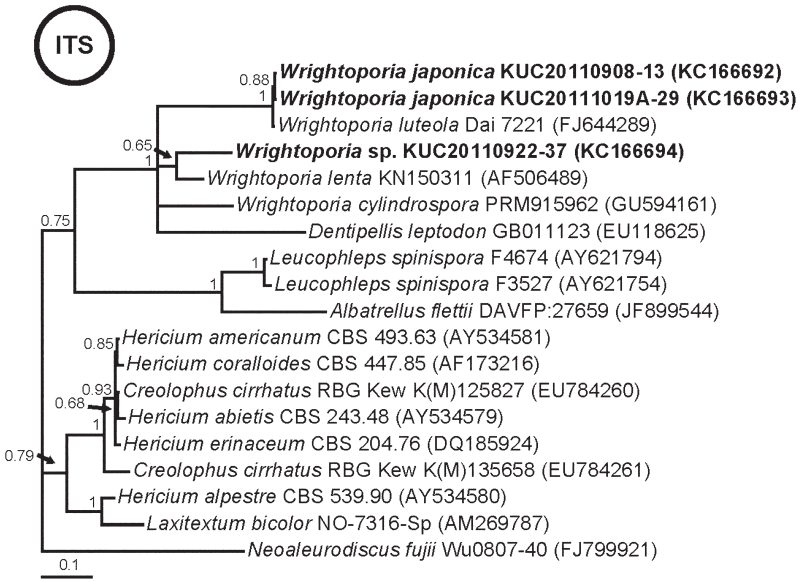

Fig. 3. ITS region 50% majority-rule consensus tree of *Wrightoporia* spp. and allied species. For the construction of consensus tree, 15,000 trees resulting from Bayesian analysis were used. Posterior probabilities ≥0.50 are shown above branches. GenBank Accession numbers of the sequences are shown in parentheses.

Wrightoporia sp.–*W. lenta* clade, *W. japonica*, *W. cylindrospora* Ryvarden, and *Dentipellis leptodon* (Mont.) Maas Geest. (Fig. 3). Further study with more *Wrightoporia* samples is required to determine the species relationships and the identity of our undetermined *Wrightoporia* sp.

Acknowledgments

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